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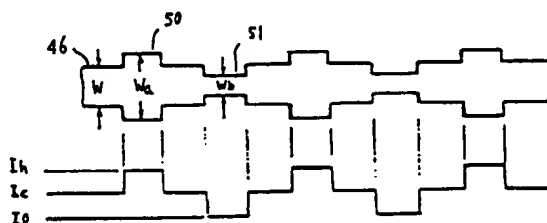
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54 Recording disc and a method for fabricating same.

57 A recording disc comprises a substrate having a tracking servo groove of spiral or concentric pattern on one surface thereof. The servo groove has a constant depth and a variable width which varies to allow generation of a position indicating signal. An eraseable recording layer is deposited on the surface of the substrate to store information signals. The recording disc is fabricated by a method involving modulating the intensity of a laser beam with a permanently stored signal and directing it to the surface of a photoresist layer on a master blank placed on a rotating turntable. The beam penetrates the full thickness of the layer. The optically excited portion of the layer spreads in lateral directions by an amount proportional to the energy. The turntable is moved relative to the laser to expose a portion of the photoresist layer in spiral or concentric pattern to the directed beam. The exposed portion is then etched to form the tracking servo groove. A replica of the groove is then formed on a substrate followed by the deposition of a radiation sensitive layer on the substrate.



**EP 0 166 199 A1**

TITLE OF THE INVENTION

"Recording Disc and a Method for Fabricating Same"

BACKGROUND OF THE INVENTION

The present invention relates to a recording disc  
5 having spiral or concentric turns of tracking servo groove  
and a method for fabricating such discs.

One approach to high density disc recording involves  
forming a tracking servo groove on the disc surface to allow  
a recording or reading laser beam to precisely follow a  
10 desired path.

A recording disc of the type shown and described in  
Japanese Patent Laid-open Publication 58-57643 is provided  
with a spiral pattern of tracking servo groove. The groove  
is modulated in depth so that lands are created at specified  
15 positions of tracks. The edges of the groove and the lands  
are sensed by diffraction of the laser beam to derive a  
tracking servo control signal and a position indicating  
signal. A recording layer is deposited on the groove to  
eraseably store information signals. However, the depth  
20 modulation results in the generation of a significantly high  
amplitude position signal which interferes with the  
information signal if the range of depth variations, or  
modulation index is greater than a certain value, which is  
approximately 10%. However, this value of modulation index  
25 would require the disc surface to vary in depth within a

range of 100 Angstroms which is impractical to manufacture.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a recording disc having a variable width groove  
5 which is easy to manufacture and a method for fabricating such discs.

According to the invention, a recording disc comprises a substrate having a tracking servo groove of spiral or concentric pattern on one surface thereof. The servo groove  
10 has a constant depth and a variable width which allows a recording or reading laser beam to be modulated in intensity to derive a tracking control signal and a position indicating signal. An eraseable recording layer is deposited on the surface of the substrate to store  
15 information signals. For a satisfactory value of width modulation index, the groove is modulated in width in a range of 2000 Angstroms.

According to a further aspect of the invention, the method for fabricating the recording disc comprises  
20 modulating the intensity of a laser beam in accordance with a position indicating signal which is to be permanently stored in the recording disc. The modulated laser beam is directed to the surface of a photoresist layer of a master blank placed on a rotating turntable. The laser beam  
25 penetrates the full thickness of the layer. The optically

excited portion of the photoresist spreads in lateral directions by an amount proportional to the amount of the energy. One of the modulated laser beam and the turntable is moved relative to the other to expose a portion of the photoresist layer in spiral or concentric pattern to the directed beam. The exposed portion is then etched to form a tracking servo groove having a constant depth equal to the thickness of the layer and a width variable as a function of the optical energy of the laser beam. A replica of the groove is formed on a substrate followed by the deposition of a radiation sensitive layer on the substrate.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of an apparatus for forming spiral or concentric turns of tracking servo groove having a constant depth and a variable width on a photoresist layer according to the present invention;

Figs. 2A to 2E are illustrations of steps for fabricating a recording disc;

Fig. 3 is a graphic representation of the depth of the groove formed in the photoresist layer plotted against the amount of its exposure to a laser beam;

Fig. 4 is a graphic representation of the width of the groove plotted against exposure; and

Fig. 5 is a plan view of a section of the variable width groove in relation to the modulated beam intensity.

DETAILED DESCRIPTION

Referring now to Fig. 1, there is shown an apparatus  
5 for producing a variable width, constant depth tracking  
servo groove on a master disc according to the present  
invention. The apparatus generally comprises an optical  
system 10 and a mechanical drive system 12. The drive  
system includes a turntable 14 driven by a motor 16 mounted  
10 on a carrier 18. Carrier 18 is threadably mounted on an  
externally threaded drive shaft 20 which is supported at one  
end on a support 22 and connected at the other end to a  
motor 24.

The optical system 10 includes a light modulator 26  
15 which modulates the intensity of a laser beam emitted by a  
laser source 30 in accordance with address signals supplied  
from a signal source 28. The modulated laser beam is  
reflected on a mirror 32 to a lens system 34 which shapes  
the cross section of the light beam into a rectangular  
20 section with the longer sides of the rectangle being  
parallel with the radial directions of the turntable 14.

On the turntable 14 is placed a master blank 36 below  
lens system 34. As shown in Fig. 2A, the blank 36 comprises  
a glass substrate 38 and a layer 40 of photoresist deposited  
25 on the substrate 38.

With the motors 16 and 24 being energized, the turntable 14 is spun at a constant angular velocity, for example. During each revolution the turntable is moved in a radial direction by the motor 24 to permit the light beam  
5 from lens system 34 to follow a spiral pattern. The operation starts with the laser beam positioned on the outermost convolution and terminates when the beam reaches the innermost convolution.

As shown at Fig. 2B, the light exposed portion of the  
10 photoresist layer 40 is etched away in a known manner to create a spiral groove 41 having a width that is variable as a function of the intensity of the beam incident on the photoresist 40, and hence in response to the address signals.

15 As will be described later, the thickness of photoresist layer 40 and the minimum intensity of the laser beam are determined so that the beam incident thereon penetrates the full thickness of photoresist layer 40 when its intensity is minimum, and therefore the the groove has a  
20 uniform depth equal to the thickness of the photoresist layer at any intensity of the beam.

As shown in Fig. 2C, aluminum or nickel is sputtered on the glass substrate 38 to form a metal film 42 that follows the surface contour of the spiral groove 41. Nickel  
25 is then electroplated over the metal film 42 to form a metal

lining 43 as a reenforcement. The metal film 42 and lining 43 form a die 44, which is removed from the glass substrate 38 to be stamped on a disc 45 of thermosetting resin to create a pattern of groove 46 which is a replica of the groove 41 (Fig. 2D). A radiation sensitive layer 47 is then deposited in a known manner on the resin disc 45 (Fig. 2E) where a spiral groove 46 is formed. The radiation sensitive material is formed of a phase transformable material such as  $\text{TeO}_x\text{GeSn}$  which changes between crystalline and amorphous states in response to the application of a laser beam or formed of a thermomagnetic material such as MnBi, MnCuBi and GdCo. These materials permit signals to be stored by application of laser beam and erased by reapplication of the beam.

As shown in Fig. 3, the depth of exposure to light from the surface of a photoresist, and hence the depth of a groove created is proportional to the incident beam intensity until a critical point  $I_t$  is reached.

According to the invention, the laser beam at minimum intensity produces an exposure which is greater than the critical point  $I_t$  and the groove produced by etching has a constant depth  $t_0$  which is equal to the thickness of the photoresist layer. The laser beam incident on the photoresist has an intensity greater than the critical point. The portion of the photoresist layer which is

optically excited by such laser beam spreads in lateral directions by an amount proportional to the amount of applied energy, creating a groove having a variable width proportional to the incident beam intensity.

5           The laser beam has a normal value of intensity  $I_c$  in the absence of the modulating signal. Upon modulation with the digital address signals, the beam intensity increases to a maximum value  $I_h$  in response to the presence of a digital pulse of a first address signal indicating a track number, 10 for example, and returns to the normal intensity in response to the absence of the pulses of the first address signal and decreases to a minimum intensity  $I_l$  in response to the presence of a digital pulse of a second address signal representing a sector number, for example, and returns to 15 normal in response to the absence of the pulses of the second address signal. As shown in Fig. 4, the width of the groove in the photoresist varies nonlinearly as a function of exposure. The minimum intensity is higher than the critical point  $I_t$  and the normal intensity  $I_c$  preferably 20 corresponds to a point where the incremental rate of width variation begins to decrease with increase in exposure.

A section of a variable width tracking servo groove 46 is shown in Fig. 5. When the beam is at normal intensity  $I_c$ , the groove has a normal width  $W$ . In the absence of any 25 address signals the normal width portion of the groove



continues and a read beam senses the edges of this portion by diffraction in order to derive a servo control signal. When the beam is at maximum intensity  $I_h$ , the edges of the groove are offset outwardly from the center of the groove to form a portion 50 having a larger width  $W_a$  and when it is at minimum intensity  $I_l$ , the edges of the groove are offset inwardly toward the center of the groove to form a portion 51 having a smaller width  $W_b$ . As the read beam scans the groove it is maintained along its center in response to the servo control signal and is modulated in intensity with the width variations.

Information signals are recorded in the portion of recording layer 47 deposited on the groove 46.

In comparison with the prior art depth modulation technique, the width modulation technique as taught by the present invention ensures greater tolerances in manufacture. For 10% modulation index, it is shown that the invention allows the groove to vary in width within the range of 2000 Angstroms (typically, between 7000 and 9000 Angstroms) with a constant depth of 650 Angstroms. The variation range of the invention is thus 20 times greater than the variation range of the prior art.

What is claimed is:

1. A recording disc comprising:

a substrate having a tracking servo groove of spiral or concentric pattern on one surface thereof, said groove having a constant depth and a variable width, the variable width groove having offset portions along edges thereof to represent a position indicating signal; and

a recording layer deposited on said surface of the substrate.

2. A recording disc as claimed in claim 1, wherein said tracking servo groove has edge portions which offset outwardly from the center of the groove as the representation of said signal.

3. A recording disc as claimed in claim 1, wherein said tracking servo groove has edge portions which offset inwardly to the center of the groove as the representation of said position indicating signal.

4. A recording disc as claimed in claim 1, wherein said tracking servo groove has first edge portions which offset outwardly from the center of the groove as a representation of a first position indicating signal and second edge portions which offset inwardly to the center of the groove

as a representation of a second position indicating signal.

5. A method for fabricating a recording disc, comprising the steps of:

- a) modulating the intensity of a laser beam in accordance with a position indicating signal which is to be permanently stored in the recording disc;
  - b) forming a master blank comprising a substrate and a layer of photoresist thereon and placing the master blank on a rotating turntable;
  - c) directing the modulated laser beam to the surface of said photoresist layer, said laser beam penetrating the full thickness of said layer to allow the penetrated portion to be chemically etched away to form a tracking servo groove having a constant depth equal to the thickness of said layer and a width variable as a function of the optical energy of said beam;
  - d) moving one of said modulated layer beam and said turntable relative to the other to cause said laser beam to expose a portion of said layer in spiral or concentric pattern;
  - e) removing the exposed portion to form said groove on said master blank;
  - f) forming a replica of said groove on a substrate;
- and

g) depositing a radiation sensitive material on said replica to obtain said recording disc.

6. A method as claimed in claim 5, wherein the step (f) comprises:

- f1) forming a die on said master blank so that the die is a replica of said groove;
- f2) separating said die from said master blank; and
- f3) molding said substrate with said die.

7. A method as claimed in claim 5, wherein the step (f1) comprises sputtering a metal on said master blank to form a metal film and electroplating a metal on said metal film to form said die.

8. A method as claimed in claim 5, wherein said laser beam is modulated so that its intensity varies between high and low values.

9. A method as claimed in claim 5, wherein said laser beam is modulated so that its intensity varies between high and medium values in response to a first permanently stored signal and between medium and low values in response to a second permanently stored signal.

10. A method as claimed in claim 9, wherein said photoresist layer exhibits a characteristic describing the relationship between the width of said groove and the amount of light exposure, said characteristic having a transition from a high to a low rate of change in said width as a function of said amount of exposure, wherein said medium intensity corresponds to said transition.

11. A method as claimed in claim 5, wherein the modulated laser beam has a rectangular cross section, the longer sides of the rectangle being parallel to radial direction of said turntable.

12. Apparatus for forming spiral or concentric turns of groove on a master disc comprising a base and a photoresist layer thereon, comprising:

means for modulating the intensity of a laser beam in accordance with a signal which is to be permanently stored in a recording disc;

a turntable driven by a motor for supporting said master disc;

means for directing the modulated laser beam to the surface of said photoresist layer, said laser beam penetrating the full thickness of said layer at any intensity to allow the penetrated portion to be chemically

etched to form a tracking servo groove having a constant depth equal to the thickness of said layer and a width variable as a function of the intensity of said optical energy; and

means for moving one of said modulated layer beam and said turntable relative to the other to expose a portion of said layer in spiral or concentric pattern to the directed laser beam.

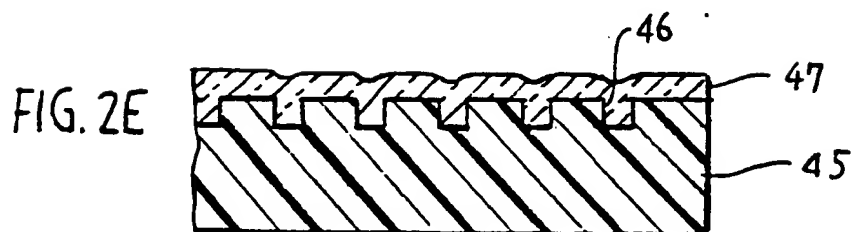
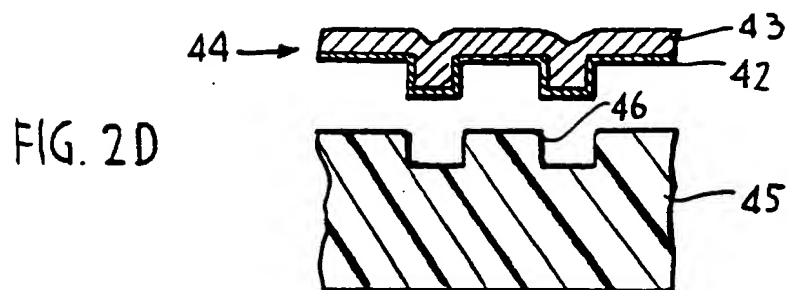
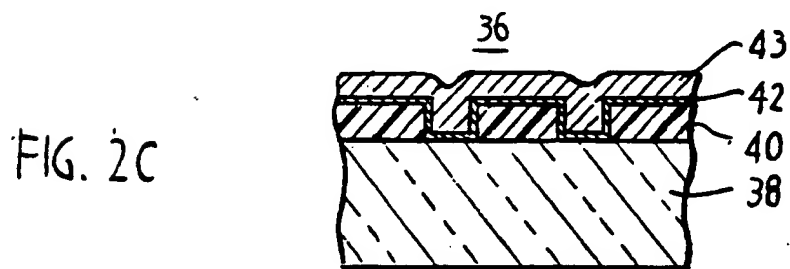
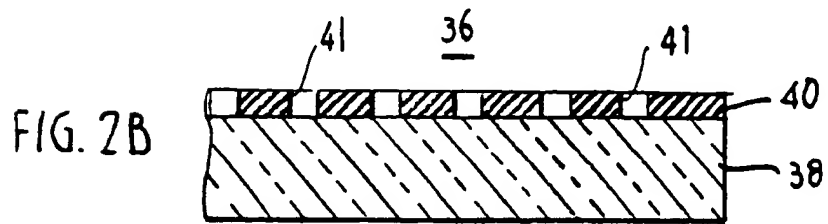
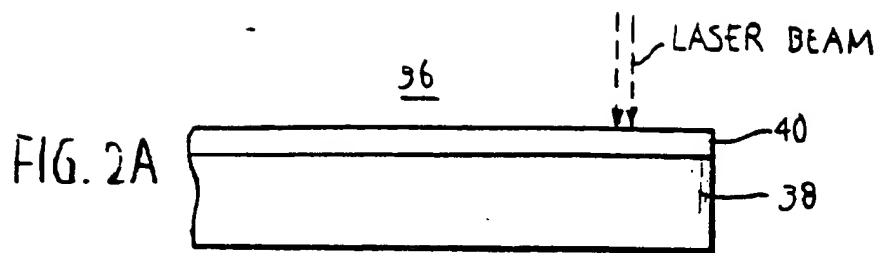
13. Apparatus as claimed in claim 12, wherein said laser beam has a variable intensity varying between high and low values.

14. Apparatus as claimed in claim 12, wherein said laser beam has a variable intensity varying between high and medium values in response to a first permanently stored signal and between medium and low values in response to a second permanently stored signal.

15. Apparatus as claimed in claim 14, wherein said photoresist layer exhibits a characteristic describing the relationship between the width of said groove and the amount of light exposure, said characteristic having a transition from a high to a low rate of change in said width as a function of said amount of exposure, wherein said medium intensity corresponds to said transition.



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FIG. 3

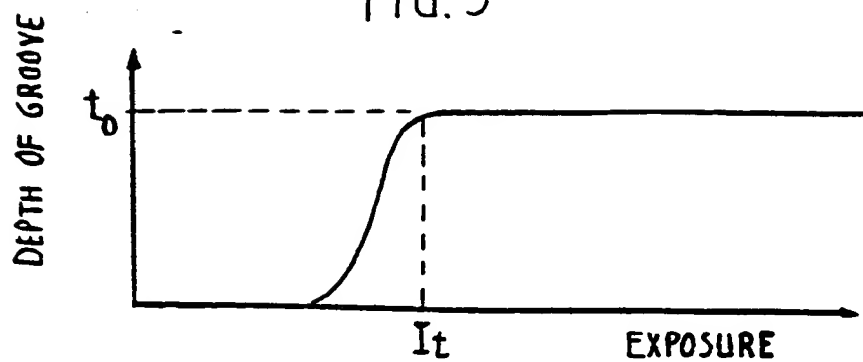


FIG. 4

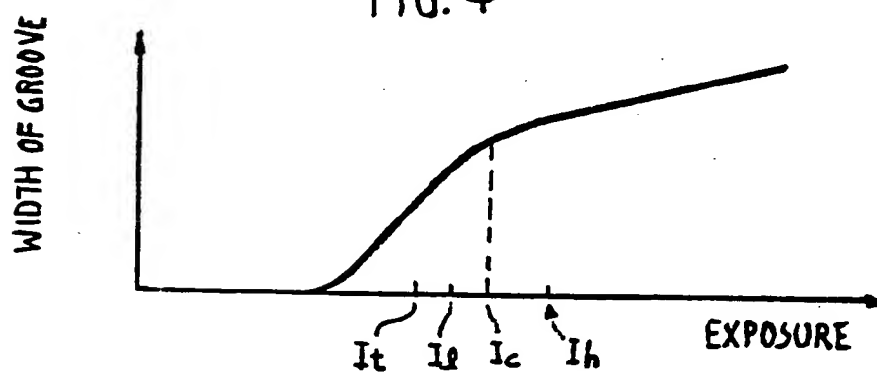
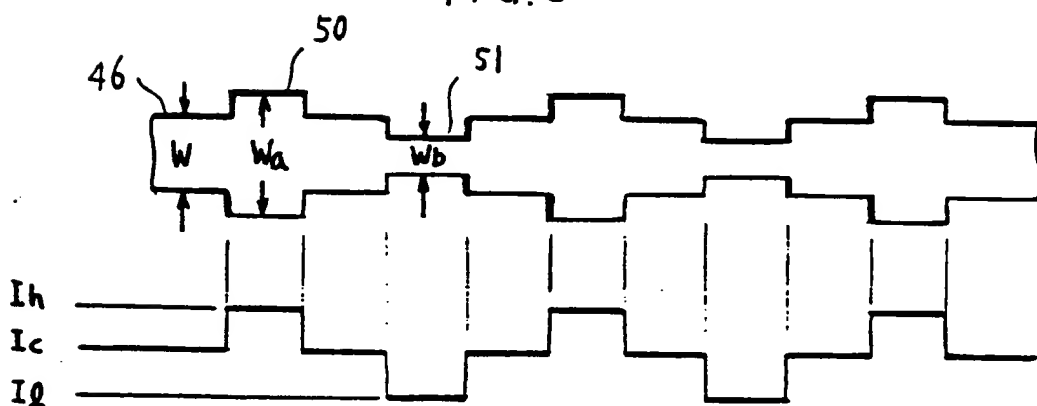


FIG. 5





European Patent  
Office

# EUROPEAN SEARCH REPORT

0166199  
Application number

EP 85 10 6241

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
A	PATENT ABSTRACTS OF JAPAN, vol. 8, no. 92, 27 April 1984, page (P-271)(1529); JP-A-59-5449 (MATSUSHITA) 12-01-1984	1	G 11 B 7/24 G 11 B 7/26
P, A	--- WO-A-8 403 988 (MATSUSHITA) * Abstract *	1	
P, A	--- PATENT ABSTRACTS OF JAPAN, vol. 8, no. 141, 30 June 1984, page (P-283)(1578) & JP-A-59-38946 (TOKYO SHIBAURA) 03-03-1984	5	
A	--- EP-A-0 061 584 (TOKYO SHIBAURA) * Abstract, figure 4 *	5	
A	--- EP-A-0 108 258 (TOKYO SHIBAURA) * Page 5, line 28 - page 7, line 11; figure 1 *	5	TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
A	--- EP-A-0 070 514 (TOKYO SHIBAURA)		G 11 B 7/00 G 11 B 23/00
A	--- DE-B-2 306 701 (TED BILDPLATTEN) -----		
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 19-08-1985	Examiner ROGNONI M.G.L.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	